



U.S. Marine Corps Corrosion Prevention and Control (CPAC) Program Overview



*Presented to
Army Corrosion Summit*

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OSD sponsored study found Cost of Corrosion to DoD is \$22.4B a year

- Annual Cost to Marine Corps Ground Equipment is \$700M/yr (2005)
- Effects Service Life, Readiness and Total Ownership Costs





Marine Corps Order 4790.18_

MISSION. To establish an effective CPAC program to extend the useful life of all Marine Corps tactical ground and ground support equipment

OBJECTIVE. Mitigate the Impact of Corrosion on USMC Assets through a comprehensive CPAC Program:

- **Existing Assets:** Assessment, Treatment and Prevention
- **New Procurements:** Implementing corrosion control in the design stage / testing of design / prototypes
- **Research and Development / Engineering:** Better products and processes to combat corrosion



- Corrosion Assessment Program developed 2004
- Recognized as model program for implementation across DoD by Defense Science Board 2005
- Corrosion Service Teams implemented 2004 - 2006
- US Army adopted USMC Program
- DoD featured article 2009

CorrDefense

DoD News about Preserving Military Assets

Volume 4, Number 3
Fall 2009
Feature

One of DoD's Smartest Corrosion Programs is Driven by the Marine Team

Popular with Marines, the Maintenance Program is Worth Emulating

By Cynthia Greenwood

Although it is the Defense Department's smallest armed force—at about 234,000 active duty and reserve troops—the U.S. Marine Corps is larger than the entire British Army. To experts who preserve the ground equipment used by Marine forces, fighting corrosion can be uniquely challenging.

While it is true that Marines operate vehicles and weapon systems similar to the Army, they practice amphibious warfare in much harsher saltwater environments. Indeed, the Marine Corps' four major bases are located on the ocean in North Carolina, California, Hawaii, and Japan.

Before experts began carrying out a Congressional mandate to establish new corrosion prevention policies throughout DoD, the Marine Corps began ramping up an under-funded corrosion prevention program that began more than 20 years ago.

In December 2002, Richard Kelly, the Marine Corps Deputy Commandant, circulated a memo that ordered officials to establish an effective corrosion prevention program for all tactical ground equipment. His aim—to reduce maintenance requirements and costs through "the development of corrosion prevention and control products, materials, technologies, and processes."

Kelly's memo said the Marine Corps was experiencing a decrease in readiness because equipment was deteriorating, a situation he said was "affecting the safety of our Marines."



Pictured is a row of MTVRs (Medium Tactical Vehicle Replacements) at Marine Corps Base Camp Pendleton, north of San Diego, California. The MTVR and other ground vehicles used by Marines are better preserved under the Marine Corps' highly structured corrosion prevention program. Photo courtesy of the Marine Corps CPAC (Corrosion Prevention and Control) office.



Operations and Sustainment Activities

Existing Assets



Corrosion Prevention and Control



Identify



Corrosion Assessment Teams

Assess

Clean



Wash Rack

Correct



Corrosion Rehabilitation Facility (CRF)

Repair

Preserve



Corrosion Service Teams (CST)

Maintain



Controlled Humidity Protection

Protect



VCI Covers





Corrosion Assessments and Database - Corrosion Category Code Definitions

Category 1 : Item requires no corrosion repair or preservatives, and has been assessed within the past 6 months. The goal at this level is to maintain the item as a category 1.

Category 2: Item requires surface preparation, spot paint, and preservation at the operator and/or organizational level. The goal of this effort should to return the item to category 1.

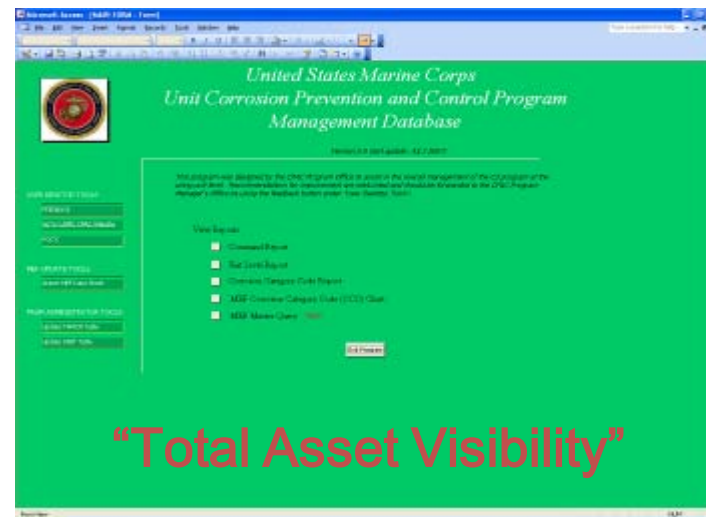
Category 3: Item requires maintenance performed beyond the operator level. Spot painting has arrested the corrosion, but the item is now in a condition that requires complete repainting and overcoat. The item must be inducted to the C3 program for repair. The goal of this effort is to induct the item into the C3 program so that it will return to the unit in a category 1 condition.

Category 4: Item requires repair to sheet metal, major frame components, paint, blasting and undercoating (e.g., replacement or repair of components such as doors, fenders, and chassis frame rails, or battery boxes due to corrosion). The goal of this effort is to immediately induct the item into the C3 program so that it will return to the unit in a category 1 condition.

Category 5: The item is degraded to a degree that requires depot level repair and replacement based on the deterioration caused by corrosion.



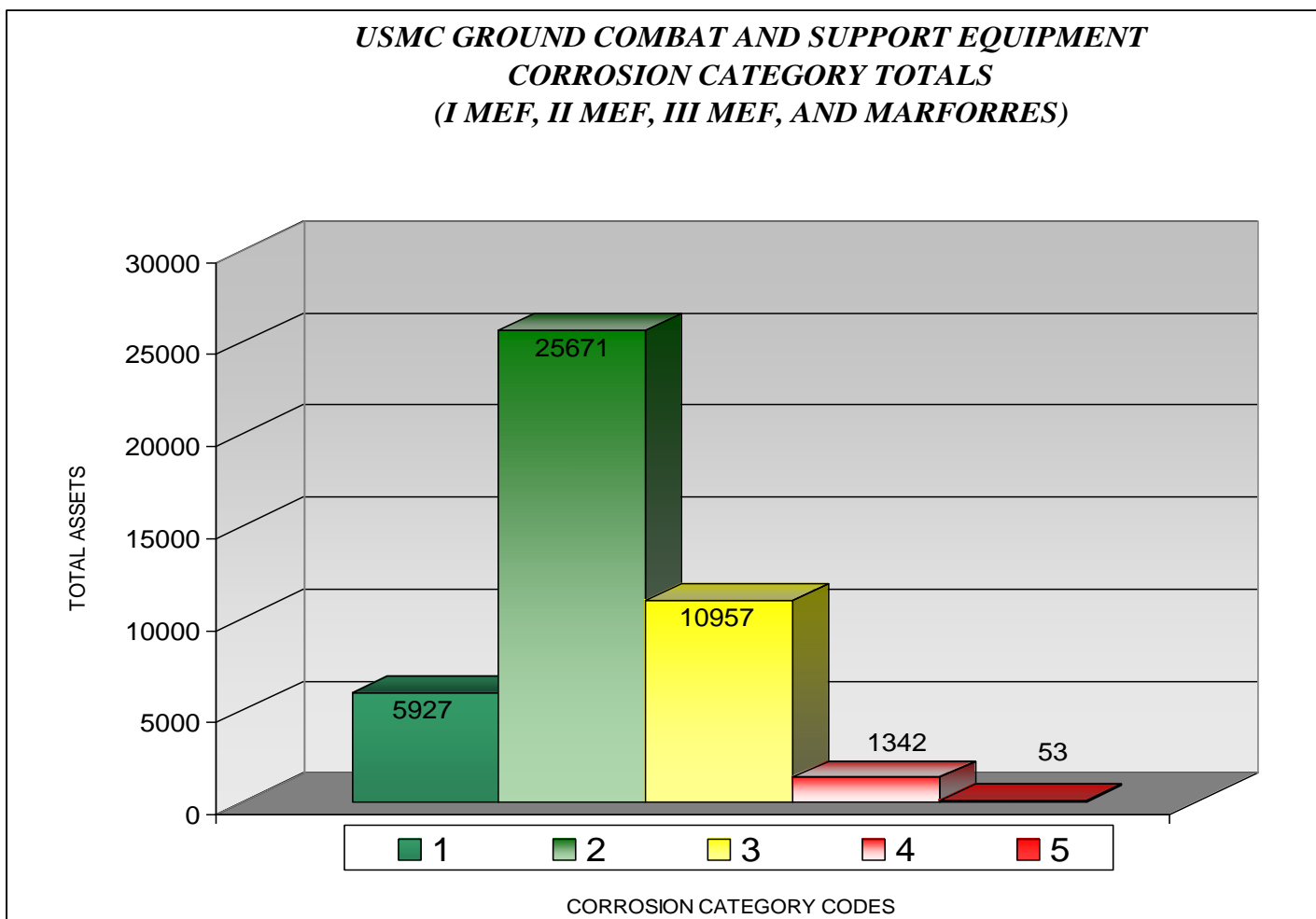
Corrosion Assessment Program and CPAC Database



- Data collected via handheld PDA and uploaded into CPAC database
 - Checklist identifying corrosion prone areas (Category 1 - 5)
- Database is updated weekly and reports are available from CPAC website
- Recent enhancements:
 1. Category Code 5 Report
 2. Equip Size Classifications
 3. CRF Scheduler
 4. CRF Longevity Report
 5. CRF "Do not Service" Report
 6. In Progress – CPAC Dashboard



Output from Assessment Program





Corrosion Service Team (CST) Operations:

- CST operations provide a means for implementing the set of corrosion control procedures for organizational level asset servicing and preservation as defined in TM 4795-12/1
 - Involves assessing, categorizing, and servicing ground combat and ground combat support equipment
 - Implemented via a mobile capability throughout the Marine Corps
- Expected Results/Outcomes:
 - Corrosion Category Code 1 assets delivered to Operational Forces
 - Extended periods between required repairs at CRFs and CSTs
 - Collection of Corrosion Category Codes for all available equipment - TAV
 - Reduction in Total Ownership Costs
 - Consistent corrosion control practices across the Marine Corps
 - Improved equipment availability throughout service life
 - Flexible customer oriented organizational level corrosion service



Corrosion Service Teams



CST Locations

Camp Lejeune, NC	Cherry Point, NC
Camp Pendleton, CA	29 Palms, CA
K-Bay, HI	Okinawa, Japan
Reserve teams that travel CONUS	
Corrosion Assessments at BIC as needed	



Corrosion Repair Facilities

- Onsite field level repair of tactical vehicles and ground support equipment
- Located at I MEF Camp Pendleton, II MEF Camp Lejeune, III MEF Okinawa and Hawaii
- Operational Management at MEF





Controlled Humidity Protection





Vapor Corrosion Inhibitor (VCI) Covers



Six Con Fuel Pump Cover



MTVR Dash Cover



Generator Covers

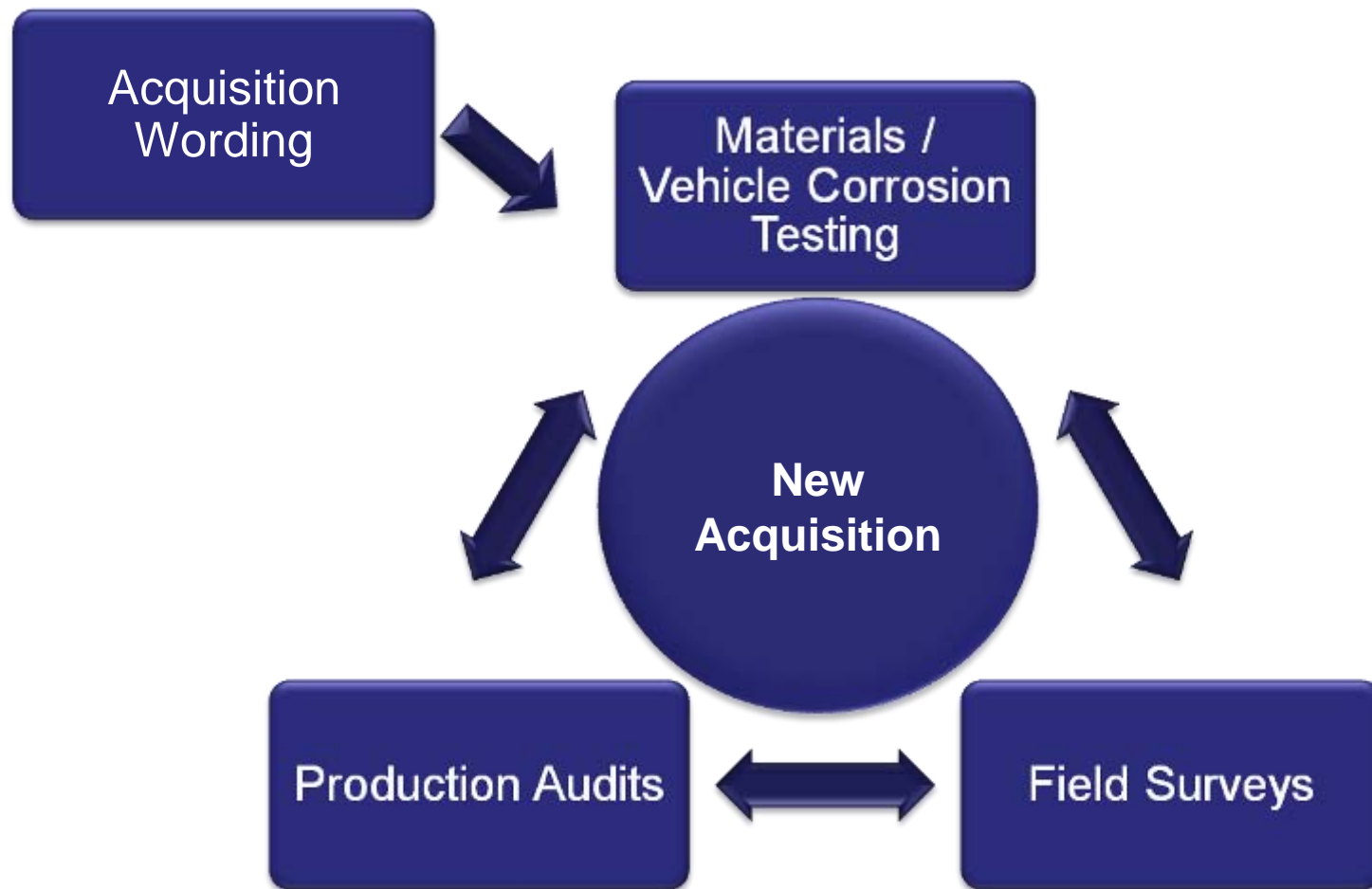


HIMARS Cover



Research and Engineering Activities

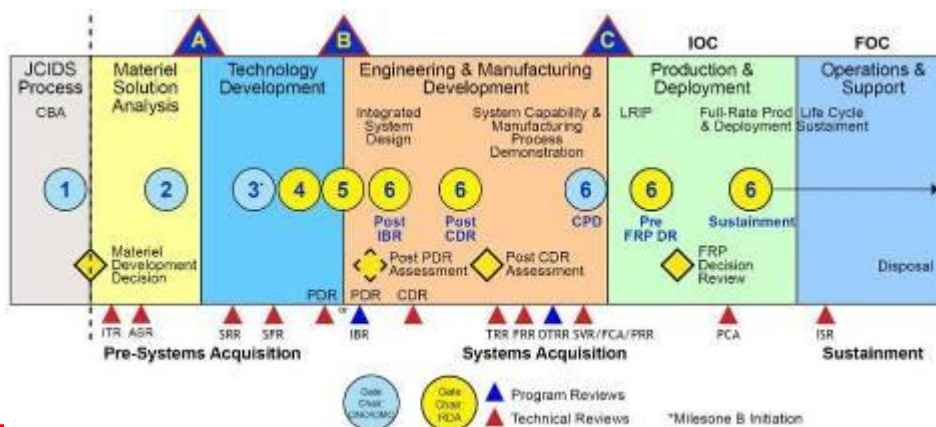
New Procurement





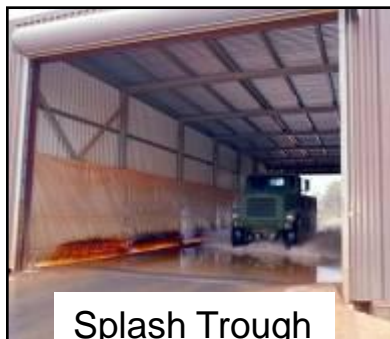
Contract Wording and Technical Reviews

- Require contractor to provide product that will achieve full service life in the intended operational environment
- Contractor must develop Corrosion Prevention Plan (CPP) during System Development and Design (SDD) phase
- Require testing of processes and products detailed in CPP (i.e. steel panel with CARC)
- Full system testing during LRIP - Combination of RAM and Corrosion Events to identify system capabilities
- Follow-on production audits and field surveys to ensure that contractor is following CPP
- DoDI 5000.67 requires all ACAT I programs to form Corrosion Prevention Advisory Teams (CPAT)





Accelerated Corrosion Test Facility



Splash Trough



Deep Water Fording Basin



Grit Trough



Mist Booth



Endurance Course Input



High Heat High Humidity

- **22 year corrosion assessment in 200+ days.**
- **Combination of RAM and Corrosion Events to identify system capabilities**
- **Corrosion deterioration matched to USMC operating environment**



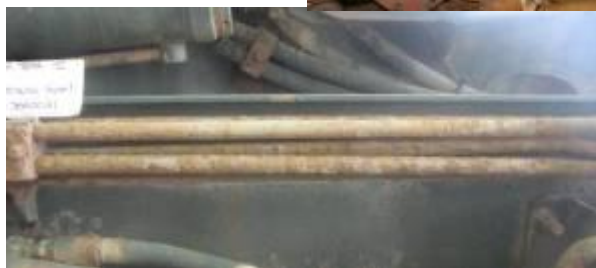
New Acquisition Support Program Managers

- Engaged with Program Managers and weapon systems throughout their life-cycle
- Early in the acquisition program provide technical guidance on corrosion control
 - Development of Corrosion Prevention Advisory Team (CPAT) Charter
 - Development of Government CPCP
 - Review of vendor CPP
 - Production audits of vendor facilities
 - Testing and inspection of prototype and LRIP vehicles
 - Recommendations for material, process and quality changes or maintenance actions for fielded systems

Examples of a few recent programs...



Logistics Vehicle System Replacement (LVSR)



Direct Program Support for Corrosion Control

- Oversight of corrosion / durability road test at Aberdeen Test Center (ATC)
- Review of test monitoring data
- Post-test inspections every 8 cycles
- Evaluation of corrosion-related failures
- Review of Oshkosh analysis and solutions with recommendations

Schedule

- Completed of road test March 2009
- Teardown inspection April 2009
- Review of test results and recommendations to PM May/June 2009

Issues

- Oshkosh raised issue with test severity (claims over-aggressive)
- Working with PM office to review contractual requirements

Sponsor: PM LVSR

Oshkosh Corporation Prime Contractor



Joint Assault Bridge (JAB)



Schedule

- Test article evaluation at ATC– Dec. 16
- Production inspection – TBD
- Environmental testing in White Sands, NM – TBD

Issues

- Main hydraulic tubes are corroded and difficult to inspect
- Many microswitches used in the launching of the bridge that may be easily corroded
- HPU's have no corrosion hardening
- Hydraulic fluid and rubber seals may be incompatible

Direct Program/Project Support for Materials and Corrosion Control

- Assessment of test article
- Recommendations for process improvement
- Recommendations for CST practices



Internally Transportable Vehicle (ITV)



LSV



PM

Schedule

- Production inspection and site visit to AGI – Nov. 10, 2008
- Test article evaluation at NATC - Nov. 20, 2008
- Trip report with recommendations - Dec. 19, 2008

Issues

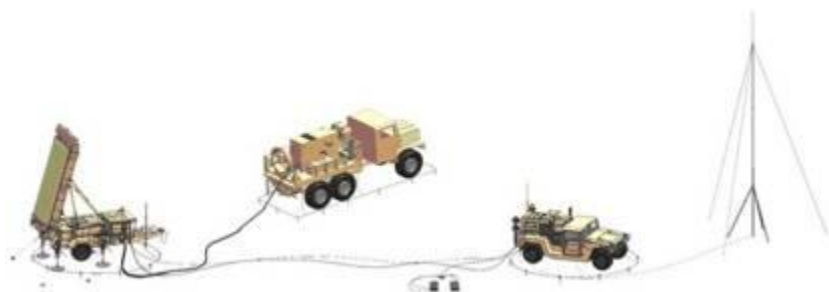
- Improper painting practices, poor health/environmental practices, no quality control measures
- Poor frame design for accumulation of dirt, lack of lubrication for tiedowns and hinges, poor paint coverage

Direct Program/Project Support for Materials and Corrosion Control

- Site visit to production facility
- Assessment of test article
- Recommendations for process improvement
- Recommendations for CST practices



Ground/Air Task Oriented Radar (G/ATOR)



Ground/Air Task Oriented Radar (G/ATOR) will combine Multi-Role Radar System (MRRS) and Ground Weapon Locating Radar (GWLR)

Schedule

- CPAC is working closely with OEM in the development of their Corrosion Prevention and Control Plan (CPCP)
- Materials and process reviews of OEM design and component issue is on-going
- Engaged in development of Environmental Test and Evaluation criteria and requirements

Direct Program/Project Support for Materials and Corrosion Control

- Assessment of test articles and major subsystems
- Recommendations for process improvement
- Recommendations for CST practices

Program Office: PEO Land Systems

Northrop Grumman Prime Contractor



Mine Resistant Ambush Protected (MRAP)



Schedule

- Perform axle upgrade paint demonstration April 2009
- Develop Modification Instruction May 2009
- Develop field-level maintenance procedures Oct 2009

Issues

- Availability delayed some site visits this Fall

Direct Program Support for Corrosion Control

- Review of current MRAP variants for corrosion issues
- Review of OEMs and Tier-1 suppliers process for corrosion control initiatives
- Develop solutions for rebuild / block upgrade
- Develop field-level maintenance procedures

Sponsor: JPO MRAP

BAE TVS, BAE York, Force Protection Industries and International Military Group Prime Contractors



Research and Engineering Activities

Test and Evaluation



Corrosion Prevention Products and Materials Program (CPPMP)

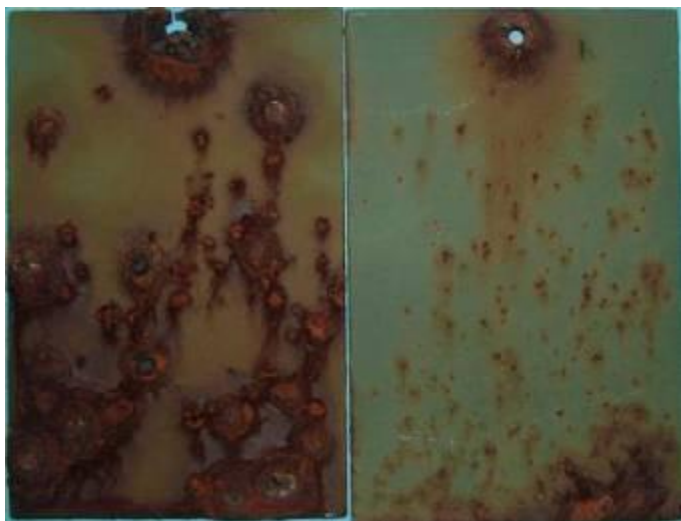
- Create a standard process of testing and authorizing products for USMC Ground Equipment use
- Allow continuous comparison of currently authorized products with those under consideration





Zinc Rich Paint (ZRP)

- Zinc-rich paint has demonstrated improvement of the corrosion resistance of carbon steel in corrosive atmospheric environments
- Focus on materials that meet the salient characteristics of Commercial Item Description (CID) A-A-59745, "Zinc-rich Coatings"
- Applied at Corrosion Repair Facilities (CRFs) and depots to bare steel
- Demonstrated significant performance improvement over Chemical Agent Resistant Coating (CARC) system



5-years Marine Exposure



Zinc-rich Paint Application to LVS Trailer



Single Component CARC (MIL-DTL-53039 Type II)

- Historically CARC application at CRFs and depots limited to MIL-DTL-64159 Type II to reduce VOCs
- Current revision of MIL-DTL-53039 provides for a low-VOC, single component CARC topcoat (Type II)
- Single component paints provide process improvements
 - Eliminates the need to mix paints
 - Faster dry to recoat times (without the need for baking)
- Recent trial application demonstrated improved flow and coverage
- This provides the CRFs and depots the flexibility to use the paint system optimum for their operating environment





Spray on Bedliner

- Cargo and undercarriage areas experience rapid deterioration of CARC paints due to wear allowing for the rapid onset of corrosion
- Spray on bedliners have been used for many years in commercial applications with great success in eliminated coating damage to the substrate
 - Spray on pickup truck bedliner
 - Lining of train cargo containers
- There are 2 CIDs for these materials: polyurethane (A-A-59719) and polyurea (A-A-59800) for types of materials
- CPAC has tested and authorized for use the polyurethane material and is completing testing on the polyurea (both over a primed substrate)





Alternatives to Hard Chrome Plating on Hydraulic Cylinders

- OSD awarded project to evaluate alternative cylinder rod finishes
- Focus on environmentally friendly materials and alternative processes that improve performance
- Leveraging work done by industry and military to identify candidate systems
- Have identified 5 alternative processes
 - Enhanced chrome with TiN topcoat over chrome
 - Enhanced chrome with thin dense chrome (United Chrome)
 - Nano particle Co-P-Si-C
 - NiB
 - Ferritic nitro-carburizing with and without TiN topcoat
- Characterization tests used to verify wear and corrosion resistance as a baseline for screening





CARC Repair Methods

- Evaluating the effects of various procedures utilized during repair and repaint of vehicles
- Variables under consideration include
 - Surface cleanliness
 - Use of wash primer
 - Use of zinc-rich primer to repair galvanized steel
- Make recommendations on best practices for use at Corrosion Repair Facilities





Appendix to DoD Corrosion Guidebook on Ground Vehicles

- Corrosion Prevention and Control Planning Guidebook provides acquisition guidance for ACAT 1 acquisition programs
- Spiral 3 (current version) provides system-specific guidance through appendices
- Currently only Aerospace and Navy Ships and Submarines had appendices
- Service and industry SMEs (including CPAC were approached) to develop an appendix specific to ground systems

- Appendix has combined USMC and US Army corrosion recommendations into a set of unified requirements
- Appendix has incorporated results of recent studies, test methodology development efforts and the current state-of-the-art in vehicle corrosion control

vehicle corrosion & coatings issues



Appendix finalized and incorporated into OSD Spiral 3



Training



SPRAY TECHNIQUE ANALYSIS AND RESEARCH FOR DEFENSE

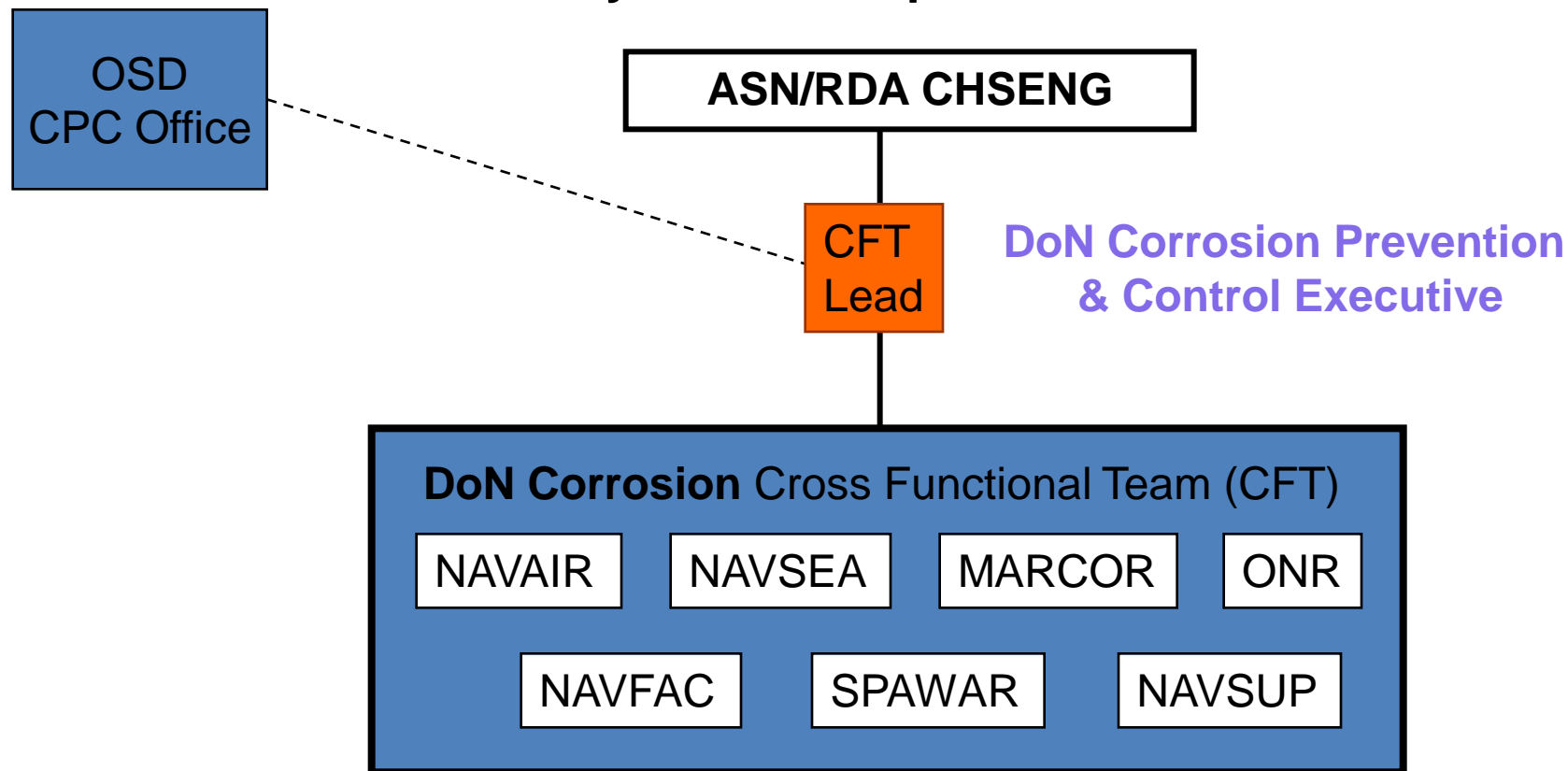
Hands-on Painter Training for the U.S. Armed Forces

- STAR-4D has been training Military personnel at UNI campus in Waterloo, IA for CARC painting
- STAR-4D will provide equipment and classroom materials to USMC Depots (Barstow and Albany)
- Selected USMC personnel will be trained by STAR-4D to be authorized instructors of class
First USMC class completed in July 09





Navy/Marine Corp Corrosion Team



National Defense Authorization Act for Fiscal Year 2009
Sec. 903, signed 14 Oct 2008, & 10 USC 2228



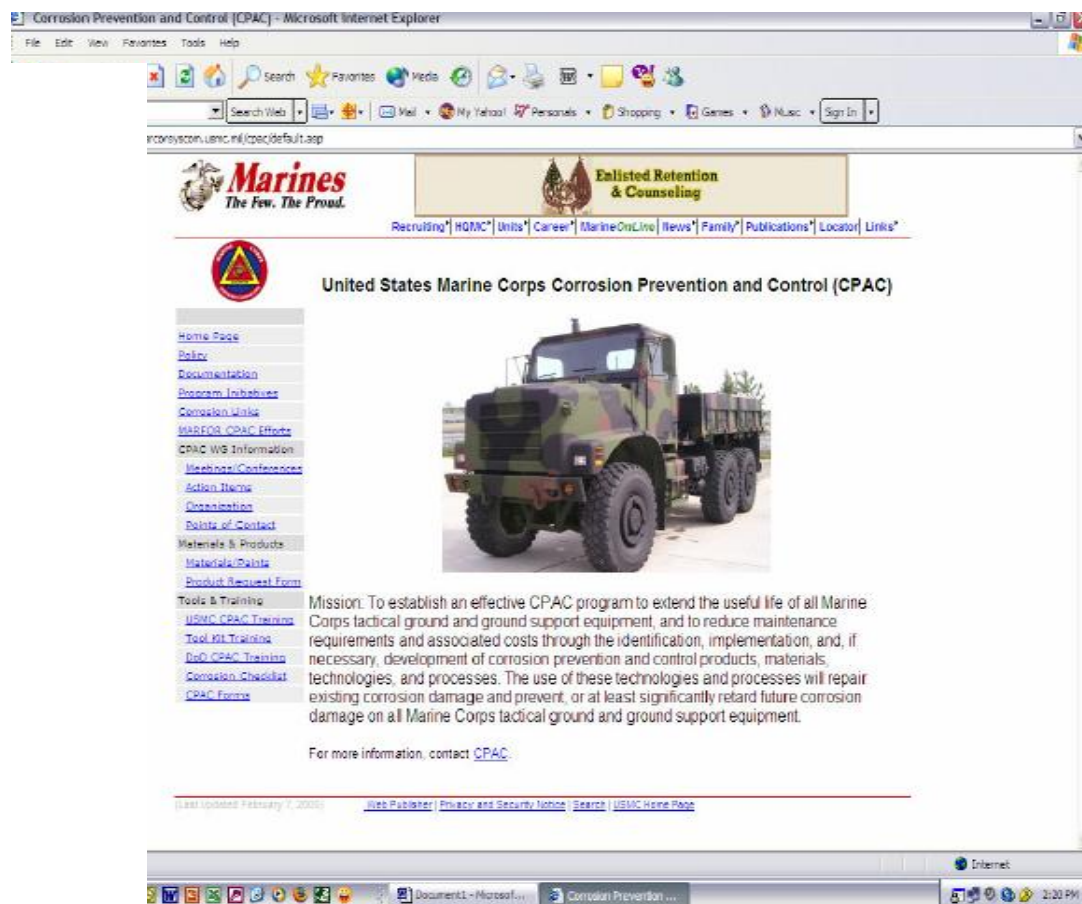
Technical Manuals

CPAC RELATED TECHNICAL MANUALS		
SHORT TITLE	TITLE	DOCUMENT TYPE
TM-4795-12/1	Organizational Corrosion Prevention and Control Procedures for USMC Equipment: April 2002	Electronic Publication
TM-4795-34/2	Corrosion Prevention and Control Rustproofing and Underbody Coating Procedures for Tactical Vehicles, Trailers, and Engineer Equipment: September 1999	Electronic Publication
TM 3080-50	Corrosion Control Procedures Depot Maintenance Activities for Marine Corps Equipment: December 1989	Electronic Publication
TM-4750-OD/1A	Painting and Registration Marking for Marine Corps Combat and Tactical Equipment: November 2004	Electronic Publication
TM 4750-OD/2	Camouflage Paint Patterns	Electronic Publication



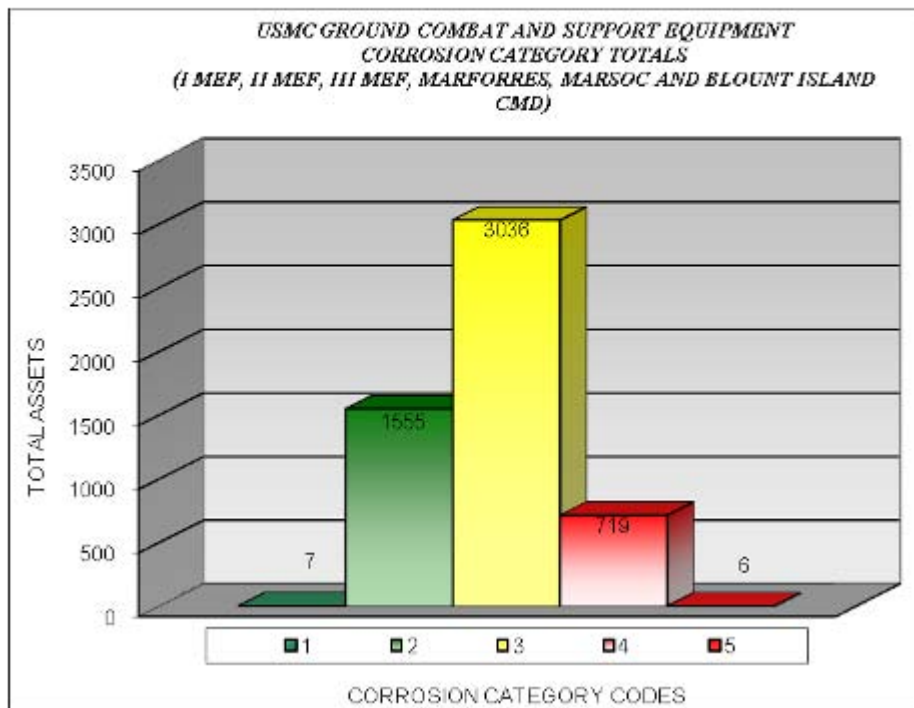
CPAC Website

- Maintained by CPAC Prgm Mngr
- Provides USMC user with a source of CPAC related information
- Product Request Form
- Approved Products
- Database and Weekly Reports
- www.marcorsyscom.usmc.mil/cpac



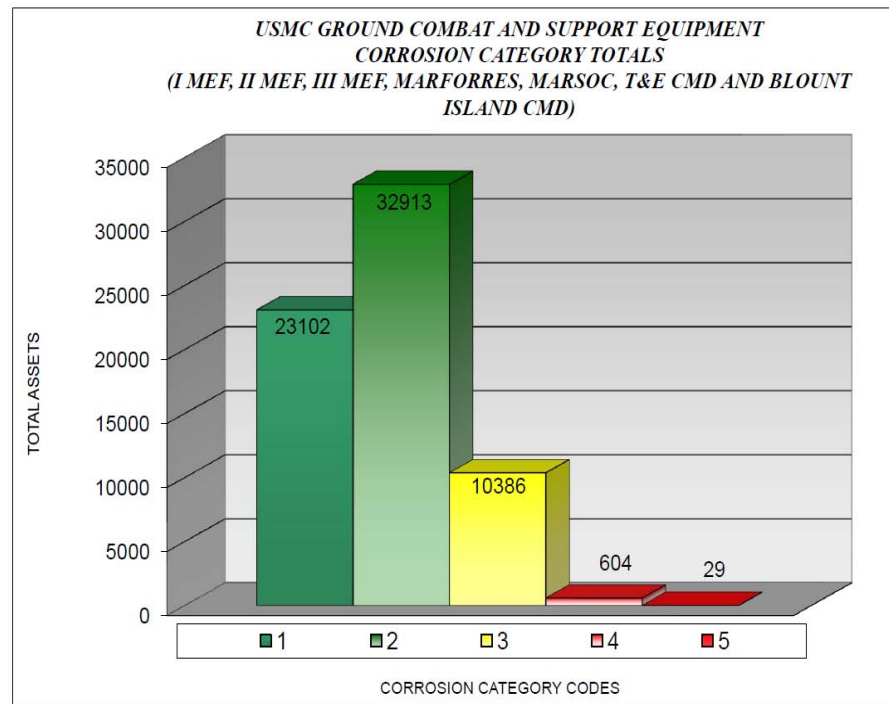


2004



(5,323 Assets Serviced and Assessed)

Dec 2009



(67,034 Assets Serviced and Assessed)

Program Goal: Identify, Correct, and Maintain